Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

INSTRUCTORS UPSKILLING, RESKILLING AND CROSS SKILLING STRATEGIES FOR THE ORGANISATION OF LEARNING AND TEACHING IN DIGITAL TVET

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Article history

Received date	**:**	5-12-2024
Revised date	**:**	6-12-2024
Accepted date	**:**	29-1-2025
Published date	**:**	20-2-2025

To cite this document:
Tahir, R. (2025). Instructors upskilling, reskilling and cross skilling strategies for the organisation of learning and teaching in digital TVET. *Journal of Islamic, Social, Economics and Development (JISED)*, 10 (70), 210 - 230.

Abstract: *Rapid changes and emerging technologies have led to shifting labour market demands and significant transformations in the education and training sector. As traditional industry processes are reshaped by advanced technologies and digitalisation, new occupational profiles are emerging. As a result, young professionals entering the workforce must acquire new competencies to navigate these changes. In response to the rapidly evolving demands of the global workforce, this article addresses the imperative need for skilling, upskilling, and reskilling trainers to effectively prepare the future professionals. The article targets TVET (Technical and Vocational Education and Training) instructors and educational leaders, focusing on strategies to enhance their competencies and adapt to innovative teaching methodologies. Using a combination of the Nominal Group Technique (NGT) and Interpretive Structural Modelling (ISM) approaches, the article systematically gathers insights from 9 TVET experts, each with more than ten years of experiences who identifies and prioritizes strategies for effective TVET instructors' professional development. The combination of these methods facilitates the collection of expert opinions and the structuring of complex relationships between various factors influencing trainer effectiveness. The outcomes emphasize the adoption of i) technology-enabled learning management. ii) innovative instructional setting/hybrid and iii) technology-mediated session reflection and feedback. The article provides actionable insights into best practices for trainer development, stressing the importance of organisation synchronous and asynchronous sessions. By outlining these prioritized strategies, the article aims to equip trainers with the necessary skills to meet the challenges of tomorrow's workforce and enhance the quality and relevance of vocational education and training.*

Keywords: *TVET Instructors, Teaching and Learning, Skills, Industry 4.0, Digitalisation, NGT, ISM.*

Introduction

As industries worldwide undergo rapid transformation due to digitalisation and Industry 4.0, Technical and Vocational Education and Training (TVET) systems must evolve to meet emerging demands. In Malaysia, the New Industrial Master Plan (NIMP) 2030 highlights the critical need to revitalise the manufacturing sector. This initiative positions manufacturing as a cornerstone of economic growth, with the sector employing 17% of the nation's workforce (MITI, 2023). However, TVET systems, particularly their instructors, face numerous challenges in aligning skills and teaching methodologies with industry requirements, an issue exacerbated by the accelerating pace of technological advancements.

Industry 4.0, driven by advancements in automation, artificial intelligence, and digital technologies, has rapidly transformed global work processes, forcing TVET systems to adapt accordingly (Stolte, 2021). In Malaysia and other ASEAN countries, TVET institutions struggle with limited awareness and insufficient readiness among instructors to integrate Industry 4.0 competencies into L&T processes (Adnan et al., 2021; Ho & Phua, 2021). Studies show that this gap is significant, particularly in the context of preparing instructors to adopt and teach cutting-edge skills required by evolving industries (Ho & Phua, 2021; Ismail & Hassan, 2019; Nurjanah & Ana, 2022).

These challenges are compounded by broader issues such as misalignment between TVET curricula and industry demands, a lack of emphasis on lifelong learning, and difficulties in integrating digital technologies into the delivery of education and training (Ismail & Hassan, 2019; Spöttl, 2020). The COVID-19 pandemic has further magnified these issues, exposing the vulnerabilities of traditional, in-person teaching models and underscoring the urgent need for technology-driven innovations in TVET. During the pandemic, remote and hybrid learning models revealed both the opportunities and limitations of digitalisation within TVET institutions (Kidd & Murray, 2020; Shay & Pohan, 2021).

In this context, as industries demand higher levels of digital competence and adaptability, the role of TVET instructors becomes increasingly critical. These educators are tasked not only with bridging the gap between industry and education but also with ensuring that students develop the digital and technical skills essential for success in the modern workforce (Tucker, 2021). Addressing these challenges requires targeted interventions, including strategies to close digital literacy gaps, overcome infrastructure constraints, and foster a dynamic and relevant learning environment (ILO, 2020; Liu et al., 2020). A comprehensive review and enhancement of existing TVET frameworks are necessary to prepare graduates to meet the demands of a technology-driven economy effectively (Carter et al., 2020; Spöttl & Windelband, 2021).

To address the challenges posed by rapid technological advancements, continuous upskilling, reskilling, and cross-skilling of TVET instructors are imperative. This includes developing their technical expertise but also enabling them to manage hybrid instructional models incorporating digital tools and resources effectively (Raihan Tahir & Zuraidah Abdullah, 2023; Liu et al., 2020). The pandemic further underscored this necessity, as instructors were forced to adapt to remote and hybrid teaching models almost overnight, highlighting gaps in digital preparedness and infrastructure (Shay & Pohan, 2021).

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
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DOI: 10.55573/JISED.107017

By focusing on professional development and fostering a culture of continuous learning among instructors, TVET institutions can significantly improve the quality of L&T processes. Digital transformation requires continuous upskilling of TVET instructors to integrate blended learning models effectively (Raihan Tahir & Zuraidah Abdullah, 2023). Such efforts will help bridge existing skills gaps, prepare students for the challenges of a dynamic, technology-driven economy, and ensure that TVET graduates are well-equipped to contribute to Malaysia's industrial and economic growth. This article explores the critical need for comprehensive upskilling, reskilling, and cross-skilling of TVET instructors as a foundation for aligning with the demands of the modern workforce and ensuring the sustainability of TVET education in a rapidly evolving world.

Problem Statement

The rapid digitalisation of the TVET sector, driven by advancements in technology and evolving labour market demands, underscores the urgent need for skilling, upskilling, and reskilling TVET instructors to prepare them for the future workforce (ILO, 2020; Liu et al., 2020). Efforts by Malaysian ministries, such as the Ministry of Education's Digital Education Learning Initiative Malaysia (DELIMA) and other strategic plans, aim to integrate digital technologies into TVET (DELIMA, 2020; MAMPU, 2018; EPU, 2021). However, challenges persist gaps highlighted in technology access and instructional practices (Assunção & Gago, 2020; Kidd & Murray, 2020). These challenges including inadequate infrastructure, digital literacy among instructors, and the rapid shift to remote learning during the COVID-19 pandemic are also common in Malaysia.

The digital divide among instructors by factors like gender, seniority, and the disparity in digital skills, impedes the effective implementation of digitalisation in TVET (Gan & Sun, 2021). This divide hampers instructors' ability to integrate technology into their teaching and align with Industry 4.0 requirements (Abdul Suki et al., 2018). The shortage of qualified instructors and their limited experience in digital pedagogical methods further contribute to the problem (Saipudin & Suhairom, 2021; Kuntadi et al., 2022).

To address these challenges, there is a need for comprehensive professional development for TVET instructors, focusing on digital skills and pedagogical competence (EPU, 2015; Azman & Ibrahim, 2018). Additionally, TVET programmes must be re-evaluated to incorporate advanced technology and digitalisation to meet industry demands and bridge the existing gaps (Bezuidenhout, 2018; Spöttl & Windelband, 2021). This transformation will ensure that TVET institutions produce graduates who are well-prepared for the technological advancements and evolving job profiles of the future.

Research Objective

To explore strategies for upskilling, reskilling, and cross-skilling TVET instructors to enhance their competencies in organizing effective learning and teaching practices in Digital TVET environments, aligning with the evolving demands of Industry 4.0.

Research Questions

The guiding research questions are as follows:
RQ 1 What are the proposed strategies for upskilling, reskilling and cross-skilling of TVET instructors, according to experts' consensus to effectively organise learning and teaching in Digital TVET?
RQ 2 Which of the proposed strategies according to TVET experts' consensus, should be

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
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prioritised to effectively organise learning and teaching in Digital TVET?

Literature Review

The subheadings below discuss and position technology as a transformative tool. The adaptability of TVET programmes to emerging digital pedagogical approaches, the integration of diverse digital tools, and the reconsideration of traditional practices in favour of innovative learning methodologies collectively contribute to the ongoing revolution in TVET delivery in Malaysia. The discussion aligns with the needs of Industry 4.0, ensuring that TVET remains a cornerstone in preparing learners for the evolving demands of the workforce.

Leveraging on Technology Adaptation

The dynamic nature of the industry exerts a profound influence on the TVET ecosystem, shaping critical aspects of the Learning and Teaching (L&T) process, including curriculum, delivery, and assessment (Spöttl, 2017). The advent of cutting-edge learning technologies has ushered in a new era in education, introducing innovative platforms such as Massive Open Online Courses (MOOCs), Personalised Learning Environments (PLEs), and Adaptive Learning Systems (ALS). These developments underscore a fundamental shift towards individualised, networked, and Artificial Intelligence (AI) -managed learning approaches, reflecting the evolving needs of the industry and the demands of the Fourth Industrial Revolution.

The implications of these advancements are not confined to theoretical concepts but extend to transformative changes in instructional methods. The integration of flipped classrooms, learner-driven assignments, and diverse media, including video and digital applications, has revolutionised the teaching process, rendering it more engaging and effective for contemporary, time-efficient learners (Al-Murshidi, 2020; Sumardi & Nugrahani, 2020).

In response to the COVID-19 pandemic, the educational landscape witnessed accelerated changes, with scholars such as Code et al. (2020) noting a significant impact on pedagogical approaches. Blended learning, personalised, and individualised instructional methods emerged as resilient strategies to provide flexible and tailored learning experiences in challenging times. The imperative to adapt to these changes showcases the resilience and flexibility inherent in TVET programmes.

Furthermore, the integration of online activities, interactions, materials, and assessments, as advocated by Juhary (2020), represents a pivotal shift in the TVET paradigm. Collaborative technologies play a crucial role in replicating face-to-face interactions within the online learning environment, adapting TVET to the realities of the digital era (Nguyen & Nguyen, 2019). In leveraging and integrating these technologies, technical TVET instructors have a unique opportunity to enhance the L&T experience (Grenčíková et al., 2021) and promote student-centred learning (Höpfner, 2009), particularly in the delivery of theory-based content.

The digital resources available to TVET instructors are diverse, ranging from Learning Management Systems (LMS) that facilitate comprehensive course management to multimedia resources, interactive whiteboards, educational apps, virtual labs, and social media. Each tool contributes uniquely to visual and interactive content delivery, gamified and interactive learning experiences, hands-on experiential learning, and collaborative project work, respectively (Nguyen & Nguyen, 2019).

The debate surrounding the efficacy of online labs, as explored by Brinson (2015) and Stoeckel (2020), challenges traditional preferences for hands-on experiences in TVET. These discussions provide nuanced insights, suggesting that online labs can be as effective, if not more so, in terms of content knowledge attainment. The efficacy of online labs challenges the conventional narrative and opens avenues for exploring flexible and accessible learning arrangements without compromising learning outcomes.

Technology and TVET Instructor Competence

However, a critical analysis of the competency profile for vocational training officers reveals a minimal focus on digital competence and pedagogical digital competence. Despite variations in their perspectives, scholars unanimously recognise the challenges and opportunities presented by online learning (Chuah & Mohamad, 2020; Sumardi & Nugrahani, 2020; Sepulveda-Escobar & Morrison, 2020) and stress the importance of support and collaboration among various stakeholders, including teachers, parents, and relevant authorities (Chuah & Mohamad, 2020; Kidd & Murray, 2020).

Blended learning approaches, incorporating both synchronous and asynchronous elements, are highlighted as essential for effective learning experiences. The scholars emphasise the need for flexibility and adaptability in teaching practices, particularly in the online learning environment. Teachers are encouraged to explore new ideas, mechanisms, and platforms to engage with students effectively (Sumardi & Nugrahani, 2020).

Divergent views among scholars exist. One focuses on technology education (Code et al., 2020) and another on Initial Teacher Education programmes (Sepulveda-Escobar & Morrison, 2020). Despite these differences, a common thread is the emphasis on the uncertain orientation of the future of education and the necessity for fundamental changes in the system (Kidd & Murray, 2020; Code et al., 2020).

The ASEAN region discusses the limitations of the current online teaching approach, emphasising the need for reinforcement and reflection (Chuah & Mohamad, 2020) and stresses the importance of academic collaboration and knowledge sharing for enhancing teaching strategies advocating for systematic and effective online education through diverse activities and interactive learning (Juhary, 2020). The advocates for the flipped classroom model cite advantages like increased interest and time efficiency (Sumardi & Nugrahani, 2020). These insights collectively underscore the challenges, opportunities, and necessary adaptations in online learning and teaching.

The crucial aspect of investing is in teacher quality to realise technology's benefits fully (Tucker, 2016). The literature discussed lays emphasis which aligns with Tucker's (2016) on the evolving competency profile of technical TVET instructors and the importance of bridging the gap in digital and pedagogical competence.

The impact of advanced technology has necessitated a shift in occupational profiles, requiring educators to focus on procedural, cognitive, emotional, and social skills (Spöttl, 2020). Educators must adapt their teaching strategies to integrate technology, ensuring students acquire the skills necessary for success in the media-powered environment.

Technology and Delivery in TVET

The landscape of online learning sees technology playing a pivotal role in delivering instructional content (Majumdar et al., 2021; Harasim, 2017). Amidst the COVID-19 pandemic,

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Journal of Islamic, Social, Economics and Development (JISED)
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DOI: 10.55573/JISED.107017

the swift adoption of digital transformation in the L&T process, facilitated through technologies and the Internet, has been noted (Gan & Sun, 2021). Synchronous and asynchronous learning situations have taken the lead, offering a platform for simulations and shared resources.

Scholars present contrasting views on the role of technology in instructional delivery. Some emphasise technology substituting teachers, while others point to the successful adaptation of digital transformation through the L&T process. However, a consensus exists on the potential of internet-mediated learning to efficiently prepare students for future industries and multidisciplinary technologies, emphasising practicality and industry relevance.

While remote learning is deemed suitable for theoretical courses, practical courses involving real or ideal practices pose challenges (Assunção Flores & Gago, 2020). Motivation and human factors, however, can overcome these limitations (Herrera et al., 2006). stress the crucial role of human and social factors in remote experimentation, advocating for higher motivation and lower scepticism to enhance the educational value of remote learning experiences.

Although the configurations for participant groups, interaction tools, and activity-supporting tools for the implementation of remote experiments have been outlined (Herrera et al., 2006), the lower-ability students tend to rate remote labs more effectively, suggesting they may be particularly suitable for students with visual or flexible learning styles. On the same note, the effectiveness of a lab, regardless of its form, with active teacher involvement is crucial in online classrooms (Stoeckel, 2020).

The online learning environment presents challenges such as limited internet connectivity and reduced interaction, particularly in asynchronous distance learning (Bagley et al., 2015). Students' expectations, often rooted in traditional learning strategies, need careful consideration when designing online learning strategies (Carter et al., 2020; Sumardi & Nugrahani, 2021). Instructors must adapt instructional methods to meet student expectations and support learning needs, recognising the differences between traditional and online settings.

Digitalisation in TVET necessitates a substantial shift in the learning and training process, emphasising technology-integrated delivery. Challenges, including limited internet connectivity and the need for adaptations to evolving instructional methods, underscore the practical difficulties students may face in the online learning process. The shift to online learning also demands a re-evaluation of assessment strategies and cultural adaptations to ensure the effective integration of technology in TVET.

Human-Centric Approach for Instructors Training

When developing practical solutions, it is essential to consider the needs and preferences of the end users—in this case, technical TVET instructors (Boller & Fletcher, 2020). Despite their central role in the Learning and Teaching (L&T) process, training improvement agendas often fail to emphasize their needs (EPU, 2015). A human-centric approach prioritizes instructors as key stakeholders, ensuring that solutions enhance their ability to facilitate learning effectively and create desired student outcomes.

This approach highlights the importance of empathy, relevance, and practical application in designing training programs. Boller and Fletcher (2020) argue that repeated practice and relevance increase retention and foster behaviour change, while disengagement occurs if training lacks practicality or alignment with instructors’ needs.

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Carl Rogers' humanistic approach underscores the role of empathy and authenticity in fostering personal growth and learning. Creating a supportive environment for TVET instructors can promote self-actualization and meaningful learning experiences. Donald Norman's (2013) human-centric design framework complements this perspective by emphasizing user-friendly solutions that solve systemic problems and prioritize continuous improvement.

Together, these perspectives advocate for designing instructor development programs that support their evolving role as learning facilitators. By addressing instructors' needs, the human-centric approach fosters impactful educational experiences while promoting adaptability and continuous growth.

Collaborativism As The New Learning Theory for 21st Century

The influence of digital technologies within constructivist approaches has led to the development of new learning environments that leverage computer software and the web to enhance social interaction, decision-making, and the construction of meaningful learning experiences (Harasim, 2017). In these environments, the role of instructors shifts from input providers in traditional classrooms to online co-learners and facilitators in virtual collaborative learning environments (Ku et.al, 2013). Instructors respond to students' thinking and assist them in developing their inquiry skills. Instructors must observe actively and intervene when there is a learning opportunity to provide effective guidance and support (Stoeckel, 2020).

Collaborative learning builds upon the constructivist approach by emphasizing the social aspects of learning and the importance of collaboration and interaction in contemporary education. Online discussions and reflective activities promote problem-solving and critical thinking skills, enabling students to apply new information in various contexts and enhance their cognitive processes (Ku et al., 2013). Through online discussions and forums, students can share their thought processes, providing valuable insights for teachers into their approaches to their work (Harasim, 2017). Digital transformation and digitalization have highlighted the importance of developing higher cognitive abilities in students. It suggests that cognition remains a prominent paradigm in education to foster the development of cognitive structures and higher cognitive abilities. In line with digitalisation, instructors should create an environment that offers both challenge and strong support without stifling the skills they aim to cultivate.

Digital transformation and digitalization have highlighted the importance of developing cognitive structures and higher cognitive abilities in students. In line with digitalisation, instructors should create an environment that offers both challenge and strong support without stifling the skills they aim to cultivate. Previous research has shown that interactive presentations can capture students' attention and enhance memory retention. Harasim (2017) emphasizes the need for learning activities that emphasize group discussion and knowledge creation using online communication technologies in the knowledge age of the 21st century. Instructors can leverage online communities of practice, learning platforms, networks, games, microworlds, and construction kits to support online discussions, discourse, and collaborative work through forums.

In TVET, online learning environments provide access to social and contextual support, utilizing technology and computers to facilitate active experiences. According to Jonassen (1994), technology enables students to actively interpret the external world and reflect on their interpretations, enhancing their thinking and learning process. It is important for students to actively participate and interact with their environment to construct their understanding of the

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
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Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

subject matter. Collaborativism positions the instructor as a learning facilitator in the collaborative learning classroom. The instructor provides collaborative work and problem-solving opportunities while focusing on student learning (Alzahrani & Woollard, 2013). When selecting collaborative technologies, instructors should consider how these tools can support collaborative task contexts and promote collaborative knowledge construction as a criterion to organise an engaging session.

Technology Integration in L&T

Technology has revolutionized L&T processes within TVET, offering opportunities for engagement, personalization, and collaboration (Kidd & Murray, 2020; Sepulveda-Escobar & Morrison, 2020). The integration of digital tools into TVET fosters transformative learning experiences but also poses challenges. Barriers such as increased workloads, resource limitations, and apprehension among educators regarding digital platforms reveal the need for comprehensive pedagogical models that align with evolving industry demands (Code et al., 2020).

The role of instructors is pivotal in this transition. They must move from knowledge transmitters to facilitators of learner-centred experiences, employing technology to enhance communication, collaboration, and engagement. For instance, video lectures enable flexible learning at a student's pace, and group activities foster collaboration and a sense of community (Bagley et al., 2015). Virtual labs and simulations have also been found to yield comparable, if not superior, outcomes to traditional hands-on labs, offering scalable solutions for practical training (Brinson, 2015; Stoeckel, 2020).

The COVID-19 pandemic accelerated the adoption of blended and remote teaching models, driving institutions to innovate with synchronous and asynchronous learning approaches (Juhary, 2020; Sepulveda-Escobar & Morrison, 2020). Digital transformation must, however, extend beyond temporary measures to embed sustainable innovations into curricula, delivery, and assessment strategies (Code et al., 2020). Project-based assessments, for example, align with authentic learning principles, encouraging critical thinking and real-world application of knowledge.

The effective integration of technology in TVET necessitates addressing both quality education and alignment with industry standards. The need for upskilling, re-skilling and cross-skilling of instructors to increase their digital competence, pedagogical approaches, multi skilling, embracing technology and adapting to the digital transformation in TVET in preparing for the future of work are the essentials to prepare learners to thrive in an increasingly technology-driven world of work.

Methodology

Two key research questions guided this study in identifying proposed ideas based on expert consensus and determining which should be prioritized for effective implementation. Nine TVET experts, each with over ten years of experience in manufacturing and mechanical-related diploma programs, contributed their expertise in assessment, management, curriculum development, and innovation. The Nominal Group Technique (NGT) was used to generate a comprehensive list of proposed ideas, while Interpretive Structural Modelling (ISM) was employed to prioritize them. NGT and ISM methodologies have proven effective in prioritizing instructional strategies in TVET institutions (Raihan Tahir & Zuraidah Abdullah, 2023) and are applied in this study to ensure a structured and data-driven approach in developing for

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Journal of Islamic, Social, Economics and Development (JISED)
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upskilling, reskilling and cross skilling strategies for the organization of L&T in Digital TVET practices.

Nominal Group Technique (NGT)

The NGT is a structured method for identifying a group's shared views on a topic. Many scholars have used it in their research. NGT helps gather collective opinions and insights on specific subjects (Harvey & Holmes, 2012). Its versatility spans various fields, including education & training (Raihan Tahir & Zuraidah Abdullah, 2024) and mental health (Mustapha et al., 2022).

Developed in the 1960s, NGT was initially designed for structured group discussions to generate solutions to specific problems (Potter et al., 2004; Harvey & Holmes, 2012). Over time, it gained popularity in fields like consumer research, healthcare, medical sciences, and social work. Researchers favour NGT because it is cost-effective and efficient (Potter et al., 2004).

One of its key strengths is ensuring that all participants contribute ideas and opinions, making discussions more inclusive (Wiggins et al., 2020; Harvey & Holmes, 2012). This structured approach allows for a thorough exploration of topics, helping researchers and professionals address complex issues effectively.

Scholars widely use NGT for data collection due to its efficiency and ease of use. Based on reviewed studies, its benefits include:

1. Ensuring all members have an equal opportunity to share ideas and opinions.
2. Generating a large number of ideas in a short time.
3. Encouraging critical evaluation of each idea's strengths and weaknesses.
4. Making sure every participant's voice from different perspective is heard.
5. Supporting group decision-making.
6. Facilitating effective data collection and meaningful discussions on specific issues.
7. Allowing participants to prioritize and focus on the most important ideas.
8. Being applicable across multiple disciplines.

During the idea generation phase, the appointed facilitator presented the stimulus question to the participants, and they responded individually to each stimulus question and wrote their solutions independently. To prevent a single train of thought, all ideas were recorded and shared with the group. The statements were then collectively reviewed and refined for clarity.

Consensus was reached through voting, using a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, 5 = Strongly Agree. Statements that achieved at least 70% expert consensus, as recommended by Deslandes et al. (2010) and Dobbie et al. (2004), were considered suitable. In this article, the suitable ideas will be used as strategies. The statements were ranked in descending order based on their percentage scores. The NGT process was completed on schedule, ensuring that decisions were made thoughtfully rather than rushed.
This makes NGT a valuable tool for researchers and professionals seeking structured, inclusive, and efficient discussions.

Interpretive Structural Modelling (ISM)

The ISM Concept Star, a licensed software, was used to develop a structured relationship model based on the idea list generated from the NGT process. The ISM methodology follows a systematic approach to analysing and prioritizing strategies through expert input and model generation. This process follows a series of key steps to ensure a logical and data-driven strategy framework.

1. Create relationship model using the suitable idea statements from NGT as input to the software. Expert vote on the relationship between two suitable idea statements. Each expert voted "yes" or "no" on the relationship between strategy statements based on their professional judgment. The guiding construct was:
   "In managing day-to-day learning and teaching processes, TVET technical instructors face various challenges in organising learning and teaching fit for Industry 4.0. The strategy is to..."
   The relationship phrase used for organisation was: "This strategy is more significant than...". The majority vote determined the final relationship structure. After the voting is completed, the ISM software generated a structured model, illustrating the hierarchical relationships among strategies. This model visually mapped how different strategies influence each other, helping to identify key driving and dependent strategies.
2. Create reachability matrix to show the representation of the intricate interconnections between these ideas.
3. Partition the ideas. The ideas were then partitioned into different levels based on their relative influence. Foundational ideas appeared at the lower levels, while dependent ideas requiring support from other actions appeared at the higher levels. This hierarchical structuring clarified the logical progression of implementation.
4. Perform MICMAC analysis. A MICMAC analysis was conducted to classify ideas based on their driving and dependent power into four quadrants. Ideas in each quadrant exhibit the following characteristics:
   Quadrant 1 - Autonomous ideas with low influence and low dependence, minimally connected to the system.
   Quadrant II - Dependent ideas with low driving power but highly influenced by other ideas. Important to note that ideas in this quadrant dependent on ideas in Quadrant IV.
   Quadrant III - Linkage ideas with highly interdependent, both influencing and being influenced. The idea in this quadrant is unstable.
   Quadrant IV - Independent ideas. Ideas in this quadrant have the driving and high influence, serving as key drivers for the overall system. Important to note that ideas in this quadrant drive ideas in Quadrant II.

Findings

The findings from this study are derived from the application of two key methods: the NGT and ISM, complemented by MICMAC analysis. The following section presents the output from both methods, highlighting their contributions to instructors upskilling, reskilling and cross skilling strategies for the organisation of learning and teaching in Digital TVET.

Nominal Group Technique (NGT)

Experts ranked all ideas by voting on the generated idea statements. According to Deslandes et al. (2010) and Dobbie et al. (2004), idea statements with 70% or more expert agreement are considered suitable for the next stage. No idea statement received less than 70% agreement, meaning that all ideas were deemed suitable. The output of the NGT process is a list of 23 suitable idea statements. **Error! Reference source not found.** below displays these idea statements, numbered in no particular order, along with their respective scores, rank priority, and the percentage of expert consensus.

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
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Table 1: Expert Consensus on Idea Statements

Idea	Statement	Percentage of Vote	Rank Priority	Expert Consensus
15	Fully digitalised the content (can be used for synchronous and asynchronous learning).	96	1	Suitable
23	Apply a mix of synchronous and asynchronous in the session structure.	96	1	Suitable
7	Apply innovative training methods.	94	2	Suitable
14	Collect feedback from students immediately after every session.	94	2	Suitable
2	Assess digital facilities and support readiness.	92	3	Suitable
11	Share content among instructors/SMEs (for example, using MOOC).	92	3	Suitable
16	Utilise technology to structure session.	92	3	Suitable
21	Provide stability /good internet connections for students.	92	3	Suitable
13	Apply creativity in creating engagement among participants (incorporate the digital setting into the physical setting).	90	4	Suitable
22	Be prepared and well-versed in your own learning platform.	90	4	Suitable
3	Specialise in the type of digital media used.	88	5	Suitable
4	Assess users' (trainer and students' readiness or prior knowledge of the content).	88	5	Suitable
18	Do preparation to conduct the session.	88	5	Suitable
5	Share resources among institutions (public and/or private).	86	6	Suitable
6	Identify talent among instructors based on needs analysis and plan employee training and development.	86	6	Suitable
1	Use rent or subscribed Learning Management System (LMS) since it is costly to develop one	84	7	Suitable
12	Determine the medium of content (text, images, videos, self-created assignments).	84	7	Suitable
17	Do more planning and scheduling.	84	7	Suitable
8	Use telegram/discord channel for communication and consultation for the student.	80	8	Suitable
10	Establish centralised management for communication and consultation.	78	9	Suitable
20	Implement cross-curricular skills amongst staff (grouping of experience, senior instructor, junior instructor, and ICT expert).	76	10	Suitable
9	Create auto reply-based answers on specific problem chatbot for the module.	74	11	Suitable
19	Provide allowance to staff-internet allowance.	70	12	Suitable

Source: Raihan Tahir. (2024). *Development of I-CODE Model for Technical Instructors in Managing Learning and Teaching Process Towards Digital TVET* (Unpublished Doctoral Dissertation). University of Malaya.

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
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Interpretive Structural Modelling (ISM)

The suitable idea statements are used as inputs in the ISM model. Developing a relationship model manually can be a lengthy and time-consuming process. However, the ISM Concept Star software simplifies this task by automatically identifying the relationships among the various ideas. It efficiently determines which ideas influence or drive the behaviour of the system under analysis. Additionally, the relationship model reveals the driving and dependent powers associated with each idea.

Relationship Model

The organizational ideas relationship model is shown in Figure 1 below. The directional arrows in Figure 1 indicate the driving factor, following the logical principle that if element A drives element B, and element B drives element C, then it can be inferred that element A drives element C. However, this logic does not hold in reverse. Element C depends on element B, and element B, in turn, depends on element A. Specifically, in **Error! Reference source not found.**, Idea 13, Idea 20, and Idea 23 drive Idea 7 and Idea 18. Then it can be concluded that Idea 13 and Idea 20 drive Idea 7 and Idea 18. However, the logic is not true otherwise. Idea 7 and Idea 18 are dependent on Idea 23, and Idea 23 is dependent on Idea 13 and Idea 20. The idea on the same level also drives each other. Idea 13 and Idea 20 drive all the other ideas, including Idea 13 and Idea 20. Idea 15 drives Idea 15 and all the other ideas except Idea 7, Idea 18, Idea 23, Idea 13 and Idea 20. It is important to note that Idea 19 has no driving power and is dependent on all the ideas before.

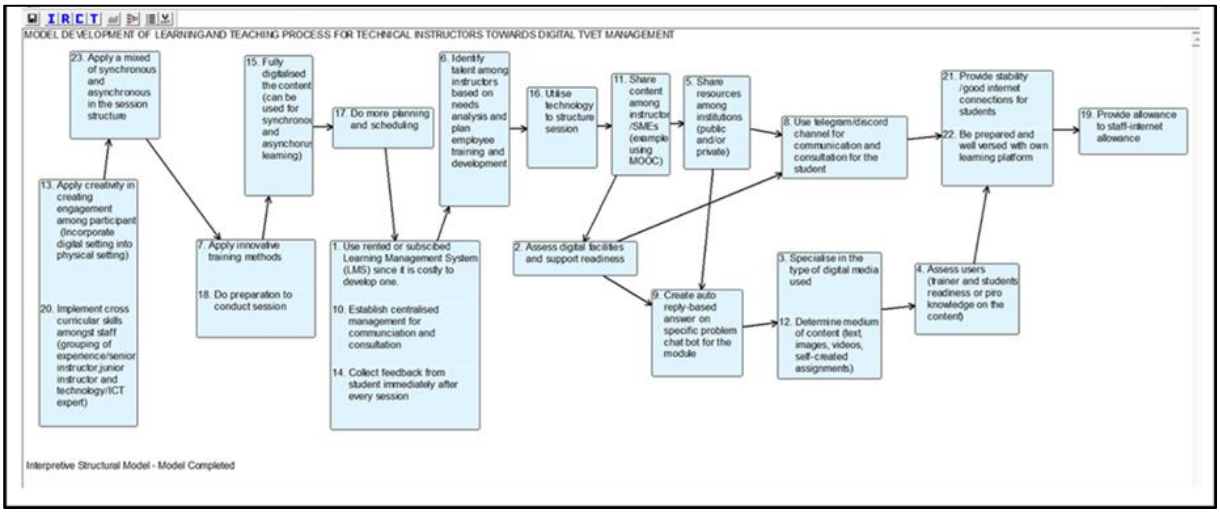

Figure 1: Relationship Model

Source: Raihan Tahir. (2024). *Development Of I-CODE Model For Technical Instructors In Managing Learning And Teaching Process Towards Digital TVET* (Unpublished Doctoral Dissertation). University of Malaya.

Reachability Matrix

To provide a visual representation of the intricate interconnections between these strategies, a reachability matrix is generated. **Error! Reference source not found.Error! Reference source not found.** displays this matrix, and it is derived directly from the relationship model. The values "0" and "1" are derived from Figure 1 using the following rule. "i" and "j" are the strategies. “i” and “j” are the ideas representing the driving power and the dependent power.
Input (i, i) is marked as "1" because i drives itself
Input (i,j) is marked as "1", because i drive j
Input (j, i) is marked as "0" because i is not driven by j.
Input (j,j) is marked as "1", because j drives itself

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

Table 2: Reachability Matrix

Idea	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Driving Power
1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	0	1	1	0	16
2	0	1	1	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	9
3	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	6
4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	4
5	0	0	1	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	9
6	0	1	1	1	1	1	0	1	1	0	1	1	0	0	0	1	0	0	1	0	1	1	0	13
7	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	20
8	0	1	1	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	9
9	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	7
10	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	0	1	1	0	16
11	0	1	1	1	1	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	1	1	0	11
12	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	6
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	22
14	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	0	1	1	0	16
15	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	0	18
16	0	1	1	1	1	0	0	1	1	0	1	1	0	0	0	1	0	0	1	0	1	1	0	12
17	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	0	1	0	1	1	0	17
18	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	20
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	3
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	3
23	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	21
Dependent Power	10	15	19	20	14	11	5	16	17	10	13	19	2	10	6	12	7	5	23	2	22	22	2	

Source: Raihan Tahir. (2024). *Development Of I-CODE Model For Technical Instructors In Managing Learning And Teaching Process Towards Digital TVET* (Unpublished Doctoral Dissertation). University of Malaya.

Partitioning

Partitioning or levelling involves categorizing the set of ideas into different levels based on their degree of dependence on one another. The ideas are organized in descending order to establish their hierarchy of importance as shown in Table 3 below. The most influential ideas, which exert the greatest impact, are placed at the top of the hierarchy. The partitioning process moves from the highest to the lowest level, with Idea 13 and Idea 20 positioned at level 16. At the lowest level, level 1 is Idea 19. The ideas for the organizational dimension have been partitioned into 16 levels.

Table 3: Partitioning of Idea Statements

Idea	Characteristics	Level
20	Implement cross-curricular skills amongst staff (grouping of experience, senior instructor, junior instructor, and ICT expert).	16
13	Apply creativity in creating engagement among participants (incorporate the digital setting into the physical setting).	16
23	Apply a mix of synchronous and asynchronous in the session structure.	15
7	Apply innovative training methods.	14
18	Do preparation to conduct the session.	14
15	Fully digitalised the content (can be used for synchronous and asynchronous learning).	13
17	Do more planning and scheduling.	12
14	Collect feedback from students immediately after every session.	11
10	Establish centralised management for communication and consultation.	11
1	Use rent or subscribed Learning Management System (LMS) since it is costly to develop one.	11

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

6	Identify talent among instructors based on needs analysis and plan employee training and development.	10
16	Utilise technology to structure sessions.	9
11	Share content among instructors/SMEs (for example, using MOOC).	8
5	Share resources among institutions (public and/or private).	7
8	Use telegram/discord channel for communication and consultation for the student.	6
2	Assess digital facilities and support readiness.	6
9	Create auto reply-based answers on specific problem chatbots for the module.	5
12	Determine the medium of content (text, images, videos, self-created assignments).	4
3	Specialise in the type of digital media used.	4
4	Assess users' (trainer and students' readiness or prior knowledge of the content)	3
21	Provide stability /good internet connections for students	2
22	Be prepared and well-versed with your own learning platform.	2
19	Provide allowance to staff Internet allowance.	1

MICMAC Analysis

The purpose of the MICMAC diagram is to analyse the drive power and dependence power of factors (Attri et al., 2013). The MICMAC diagram is obtained by using the values of the x (dependence power) and y (driving power) axes as (x, y) coordinates in a Cartesian graph. The x and y values are identified and presented in Table 3 below.

Table 3: Driving Power and Dependence Power

Idea	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
x	10	15	19	20	14	11	5	16	17	10	13	19	2	10	6	12	7	5	23	2	22	22	2
y	16	9	6	4	9	13	20	9	7	16	11	6	22	16	18	12	17	20	1	23	3	3	21

The coordinate is marked by using the idea statement number. By using these values as the Cartesian coordinate points for MICMAC diagram displayed in Figure 2 below. Each quadrant denotes a specific characteristic for the driving and dependent power.

Quadrant 1 - Autonomous ideas with low influence and low dependence, minimally connected to the system. The author has categorised Idea 16 to be in this quadrant.

Quadrant II - Dependent ideas with low driving power but highly influenced by other ideas. Important to note that ideas in this quadrant dependent on ideas in Quadrant IV. There are six ideas in this quadrant.

Quadrant III - Linkage ideas with highly interdependent, both influencing and being influenced. The idea in this quadrant is unstable. No idea in this quadrant.

Quadrant IV - Independent ideas. Ideas in this quadrant have the driving and high influence, serving as key drivers for the overall system. Important to note that ideas in this quadrant drive ideas in Quadrant II. There are 10 ideas in this quadrant.

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
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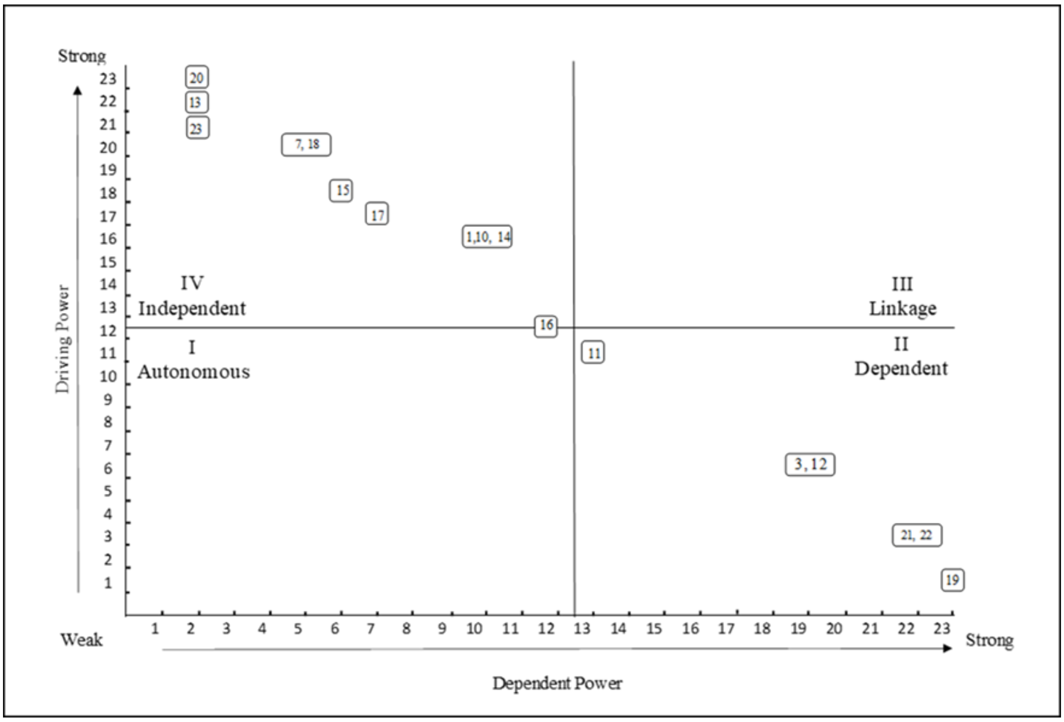

Figure 2: MICMAC Diagram

Source: Raihan Tahir. (2024). *Development Of I-CODE Model For Technical Instructors In Managing Learning And Teaching Process Towards Digital TVET* (Unpublished Doctoral Dissertation). University of Malaya.

The idea statements from Quadrant IV (independent) and Quadrant II (dependent) of the MICMAC diagram in Figure 2 are presented in Tables 4 and 5, respectively.

Table 4: Independent Idea Statements

Strategy	Statement
Idea 2	Apply hybrid that is focusing on application of theory IN practical assessment
Idea 20	Implement cross-curricular skills amongst staff (grouping of experience, senior instructor, junior instructor, and ICT expert)
Idea 13	Apply creativity in creating engagement among participants (incorporate the digital setting into physical setting)
Idea 23	Apply a mixed of synchronous and asynchronous in the session structure
Idea 7	Apply innovative training methods
Idea 18	Do preparation to conduct the session
Idea 15	Fully digitalised the content (can be used for synchronous and asynchronous learning)
Idea 17	Do more planning and scheduling
Idea 1	Use rent or subscribed Learning Management System (LMS) since it is costly to develop one
Idea 10	Establish centralised management for communication and consultation
Idea 14	Collect feedback from student immediately after every session.

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

Table 5: Dependent Idea Statements

Strategy	Statement
Idea 11	Share content among instructors/SMEs (for example, using MOOC)
Idea 3	Specialise in the type of digital media used
Idea 12	Determine the medium of content (text, images, videos, self-created assignments)
Idea 21	Provide stability /good internet connections for students
Idea 22	Be prepared and well-versed with your own learning platform
Idea 19	Provide allowance to staff-internet allowance

Discussion

The author derived from the independent statements three central themes to advancing L&T in the Digital TVET landscape. The integration of technology-enabled learning environments, innovative hybrid instructional settings, and technology-mediated session reflection and feedback offers a comprehensive framework for managing the organization of L&T in TVET institutions.

Technology-Enabled Learning Management

Technology-enabled learning environments form the backbone of modern Digital TVET, creating engaging, flexible, and interactive experiences for learners. By seamlessly blending digital and physical spaces, TVET instructors can use multimedia resources, gamification, and interactive tools to keep students motivated and engaged. A combination of synchronous and asynchronous learning further enhances flexibility, catering to the diverse needs and preferences of students, while providing both structure and autonomy in their learning journey. The integration of Learning Management Systems (LMS) takes this flexibility a step further, ensuring content delivery is both accessible and interactive. This approach not only fosters an engaging learning experience but also aligns with the demands of Industry 4.0, where digital competencies are essential for preparing students for an increasingly technology-driven workforce. Fully digitalized content supports a broader range of learning pathways, enabling institutions to provide inclusive, relevant, and industry-aligned education that meets the needs of today's digital age.

Innovative Instructional Setting/Hybrid

Innovative instructional settings, especially in hybrid environments, are key to engaging students in active learning. By blending digital and physical spaces, TVET institutions can harness creative teaching methods like gamification, simulations, and cross-curricular collaborations. This approach not only integrates technology but also fosters dynamic, flexible learning experiences that keep students motivated and actively participating. Collaboration among ICT experts, senior instructors, and junior staff in designing these hybrid environments ensures that learning is both relevant and aligned with the demands of Industry 4.0. This teamwork cultivates a space for creativity and innovation, encouraging instructors to adapt their teaching methods and enhance student engagement. As instructors apply creative pedagogical approaches, they create opportunities for deeper learning, critical thinking, and sustained interest, ultimately enriching the overall quality of education.

Technology-Mediated Session Reflection and Feedback

This theme plays a crucial role in fostering continuous improvement in teaching practices. By integrating real-time feedback mechanisms and centralized management for communication, instructors can quickly assess and refine their methods. This feedback-driven approach allows for a more personalized and adaptive learning experience, ensuring that both instructors and

Volume: 10 Issues: 70 Special Issue [February, 2025] pp. 210 - 230
Journal of Islamic, Social, Economics and Development (JISED)
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Journal website: www.academicinspired.com/jised
DOI: 10.55573/JISED.107017

students are responsive to each other's needs. The integration of immediate student feedback provides instructors with insights that help improve instructional methods, ultimately enhancing the quality of education. This dynamic feedback loop ensures that learning environments stay flexible and continuously evolve, making the teaching process more effective. Additionally, balancing synchronous and asynchronous learning is key to optimizing resources and meeting the diverse needs of learners. A 70% synchronous to 30% asynchronous learning ratio provides an efficient structure, offering flexibility in scheduling and catering to different learning preferences. This balance helps institutions better manage resources, such as instructor availability and infrastructure, while ensuring that students receive the support and engagement, they need for success.

Conclusion

This article strongly advocates for upskilling, reskilling, and cross-skilling instructors to enhance their ability to deliver effective L&T in digital TVET environments. It emphasizes the evolving role of instructors in adapting to technological advancements and highlights the critical need for continuous professional development to meet the evolving demands of innovative learning and teaching through:

Upskilling for Digital Proficiency - Shift from traditional teaching to facilitating physical, virtual and hybrid learning environments

Instructors need to develop competencies in using digital tools and platforms for collaborative learning. This requires training in areas such as creating interactive presentations, managing online communities, and employing collaborative technologies effectively. The article underscores the importance of instructors mastering digital technologies, such as learning platforms, online communication tools, and collaborative technologies. By acquiring these new skills, instructors can design interactive presentations, facilitate group discussions, and integrate tools like games and construction kits to enhance engagement and retention among learners. These strategies enhance student engagement, retention, and participation, ensuring that learning is dynamic and relevant. With these digital proficiencies, instructors are well-equipped to deliver effective education and foster a modern, interactive learning environment for the digital age.

Reskilling for New Pedagogical Approaches- Shift from teacher-centered methods to constructivist and collaborative

This demands a complete overhaul of teaching strategies. As teaching strategies evolve with digitalization, instructors may need to replace outdated approaches with skills that align with modern constructivist and collaborative learning methodologies. This involves learning the pedagogical digital competencies to guide students in inquiry-based learning, problem-solving, and critical thinking through technology-enhanced environments. The article emphasizes the role of instructors as facilitators and co-learners, focusing on guiding students in inquiry-based and problem-solving activities rather than simply delivering content. Reskilling in these pedagogical methods allows instructors to foster higher cognitive abilities in students while creating supportive, student-centred learning environments.

Cross-skilling for Multifaceted Competencies - Balanced expertise in subject matter with the ability to foster development of 21st century skills

Effective learning and teaching in a digital TVET environment require a mix of technical, pedagogical, and digital competence, increasing use of collaboration and interaction tools. Digital TVET requires instructors to possess a diverse set of competencies that blend technical expertise, pedagogical knowledge, and digital communication skills. The article discusses the need for instructors to organize content into manageable chunks, utilize collaborative technologies effectively, apply their technical expertise in creative, interactive ways that promote deeper student engagement and evaluate students through authentic assessments. This cross-disciplinary expertise ensures that instructors can meet the diverse demands of a modern, technology-driven learning environment.

Adapting to the Digital Transformation in TVET- embracing collaborative and constructivist learning models

Instructors need training in collaborative and constructivist learning models to create engaging, interactive learning environments that prioritize student interaction and critical thinking. This includes workshops on collaborative learning strategies, facilitating online communities, and using digital and collaborative tools for group projects. They should also be trained in designing interactive, student-centred activities, inquiry-based learning, and peer assessment methods. These skills help instructors create dynamic, flexible learning experiences that prepare students for the demands of the digital age, fostering deeper engagement, critical thinking, and collaboration.

Preparing for the Future of Work and TVET -creating challenging yet supportive environments that mimic real-world scenarios

In the context of TVET, where the primary goal is to prepare students for the workforce, instructors must stay ahead of industry trends and technological advancements. The article stresses the importance of creating challenging yet supportive environments that mimic real-world scenarios, ensuring students are ready to apply their skills in various contexts. Training includes simulations, case studies, problem-based and project-based learning, where students solve industry challenges and collaborate in dynamic settings.

Investing in instructor development for digital environment focusing on organisation of L&T sessions, technical subject matter, and pedagogical digital competence is non-negotiable. TVET institutional leaders need to act now, or watch technology pass by, leaving the instructors behind. Without skilled instructors to drive change, government plans and initiatives for economic growth will remain aspirations on paper.

Acknowledgements

1. Acknowledgement to funding body. The author received no financial assistance for the research, and/or publication of this article.
2. This article is based on the empirical study by Raihan Tahir and the manuscript edited to comply with the requirements of the publisher. The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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